

**CLAIMS**

What is claimed is:

1. In a voice coil actuator (100, 130, 160, 170) of the type comprising a coil (108, 118, 128, 138, 168, 178), an armature (106, 136, 166, 176), a housing (102, 132, 162, 172) and a magnet (104, 134, 144, 154, 164, 174), wherein the armature (106, 136, 166, 176) is disposed at least partially within the housing (102, 132, 162, 172) and movable relative thereto and the coil (108, 118, 128, 138, 168, 178) and the magnet (104, 134, 144, 154, 164, 174) are disposed relative to each other so as to induce movement of the armature (106, 136, 166, 176) relative to the housing (102, 132, 162, 172) when the coil (108, 118, 128, 138, 168, 178) is energized by an electrical current, the improvement comprising:
  - 10 at least one of the coil (108, 118, 128, 138, 168, 178), the magnet (104, 134, 144, 154, 164, 174) and the housing (102, 132, 162, 172) being nonuniform in orientation relative to the armature (106, 136, 166, 176), whereby displacement of the armature (106, 136, 166, 176) relative to the housing (102, 132, 162, 172) will be substantially linearly proportional to the electrical current flowing through the coil (108, 118, 128, 138, 168, 178).
  - 15 2. The voice coil (108, 118, 128, 138, 168, 178) actuator according to claim 1, wherein the movement of the armature (106, 136, 166, 176) relative to the housing (102, 132, 162, 172) is radial in nature.
3. The voice coil actuator (100, 130, 160, 170) according to claim 1, wherein the movement of the armature (106, 136, 166, 176) relative to the housing (102, 132, 162, 172) is axial in nature.
4. The voice coil actuator (100, 130, 160, 170) according to any of claims 1-3, wherein the coil (108, 118, 128, 138, 168, 178) is carried by the armature (106, 136, 166, 176).

5. The voice coil actuator (100, 130, 160, 170) according to any of claims 1-3, wherein the magnet (104, 134, 144, 154, 164, 174) is carried by the armature (106, 136, 166, 176).

6. The voice coil actuator (100, 130, 160, 170) according to any of claims 1-5, wherein the coil (108, 118, 128, 138, 168, 178) is a single winding.

7. The voice coil actuator (100, 130, 160, 170) according to any of claims 1-6, wherein the coil (108, 118, 128, 138, 168, 178) is tapered.

8. The voice coil actuator (100, 130, 160, 170) according to any of claims 1-7, wherein the housing (102, 132, 162, 172) is tapered.

9. The voice coil actuator (100, 130, 160, 170) according to any of claims 1-8, wherein the magnet (104, 134, 144, 154, 164, 174) is nonuniform.

10. The voice coil actuator (100, 130, 160, 170) according to any of claims 1-4, wherein the magnet (104, 134, 144, 154, 164, 174) is in the housing (102, 132, 162, 172).

11. The voice coil actuator (100, 130, 160, 170) according to any of claims 1-4 and 10, wherein the magnet (104, 134, 144, 154, 164, 174) is radially contained in the housing (102, 132, 162, 172).

12. The voice coil actuator (100, 130, 160, 170) according to any of claims 1-11, wherein the coil (108, 118, 128, 138, 168, 178) is linearly tapered.

13. The voice coil actuator (100, 130, 160, 170) according to any of claims 1-11, wherein the coil (108, 118, 128, 138, 168, 178) is parabolically tapered.

14. The voice coil actuator (100, 130, 160, 170) according to any of claims 1-11, wherein the coil (108, 118, 128, 138, 168, 178) is arcuately tapered.

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15. The voice coil actuator (100, 130, 160, 170) according to any of claims 1-11, wherein the coil (108, 118, 128, 138, 168, 178) is discontinuously tapered.

16. The voice coil actuator (100, 130, 160, 170) according to any of claims 1-15, wherein the magnet (104, 134, 144, 154, 164, 174) is arcuately tapered.

17. The voice coil actuator (100, 130, 160, 170) according to any of claims 1-15, wherein the magnet (104, 134, 144, 154, 164, 174) is discontinuously tapered.

18. The voice coil actuator (100, 130, 160, 170) according to any of claims 1-15, wherein the magnet (104, 134, 144, 154, 164, 174) is parabolically tapered.

19. The voice coil actuator (100, 130, 160, 170) according to any of claims 1-15, wherein the magnet (104, 134, 144, 154, 164, 174) is linearly tapered.

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